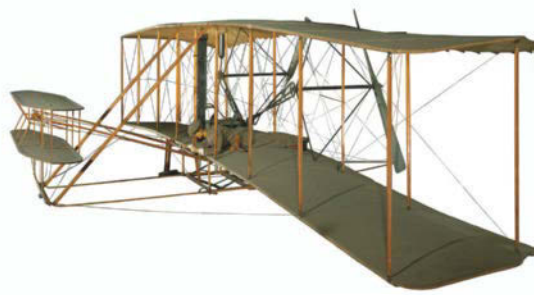
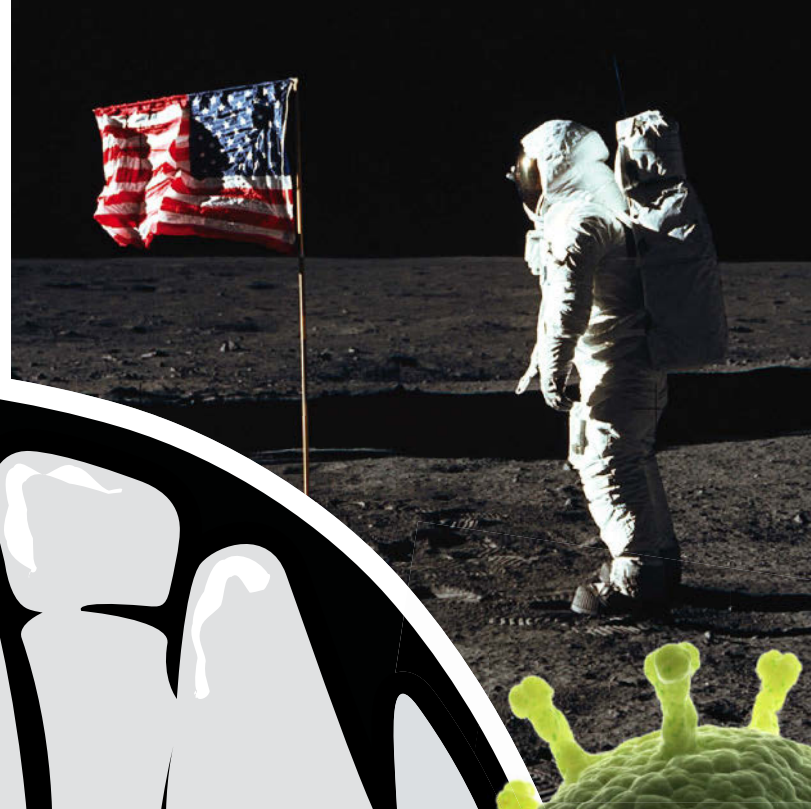
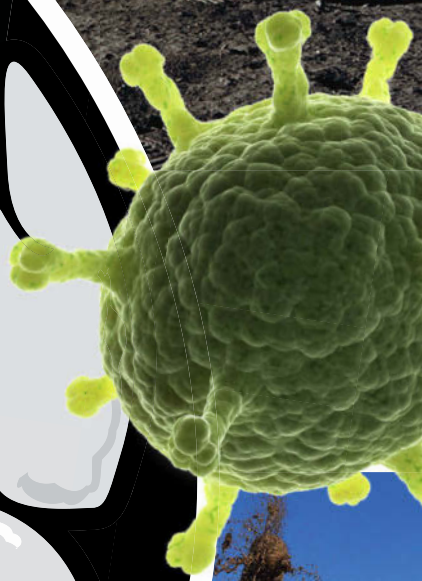
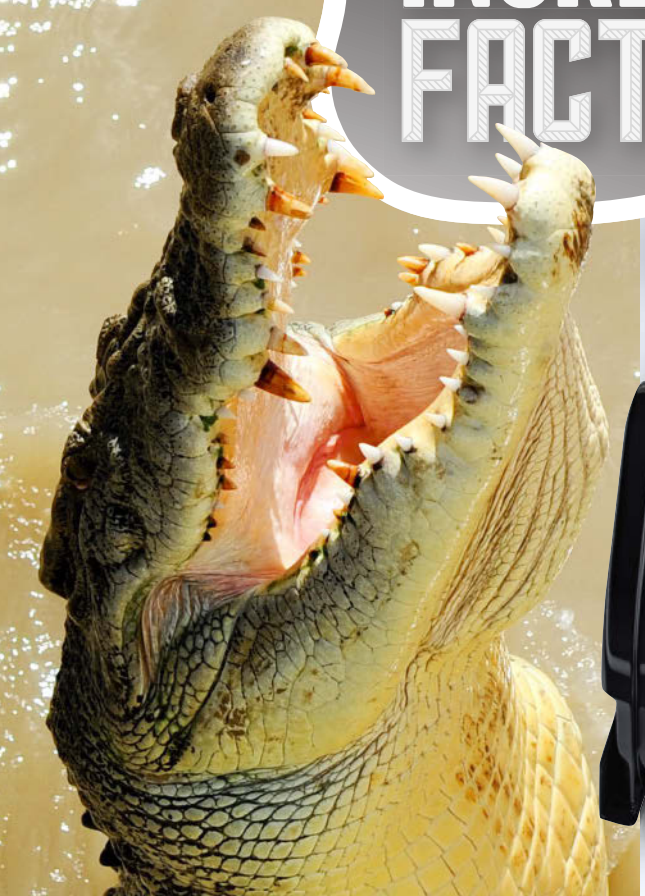




BRAIN BLAST



YOUR
REGULAR DOSE OF
INCREDIBLE
FACTS



BROUGHT TO YOU BY
HOW IT WORKS

BROUGHT TO YOU BY

HOW IT WORKS

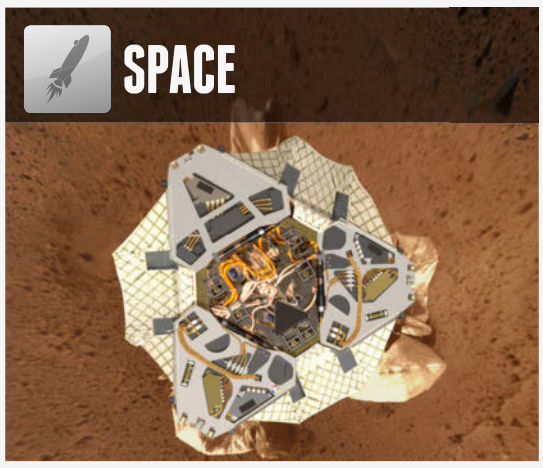
WELCOME

GET YOUR CURIOUS QUESTIONS ANSWERED

Congratulations! Another issue of Brain Dump has been delivered direct to your tablet or smartphone. As usual, it's packed with facts, stats and info encompassing a fascinating range of topics from the worlds of science, space, nature, transport and the human body. Give your brain a workout and swipe left to get started.

The Braindump Team

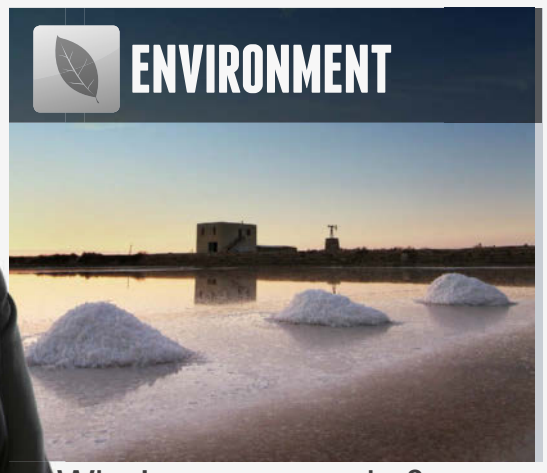
Do photons have mass?



Sending probes to Mars

The Wright brothers

Thought-powered F1 cars



Why is seawater salty?

How do touchscreens work?

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Design: Lora Barnes Photography; Getty; Thinkstock; Rex features

THAT'S AMAZING

This baby elephant enjoys a shower as one of the adults in the herd sprays water from its trunk. Elephants cover themselves in mud to protect their skin from the Sun.

THAT'S AMAZING

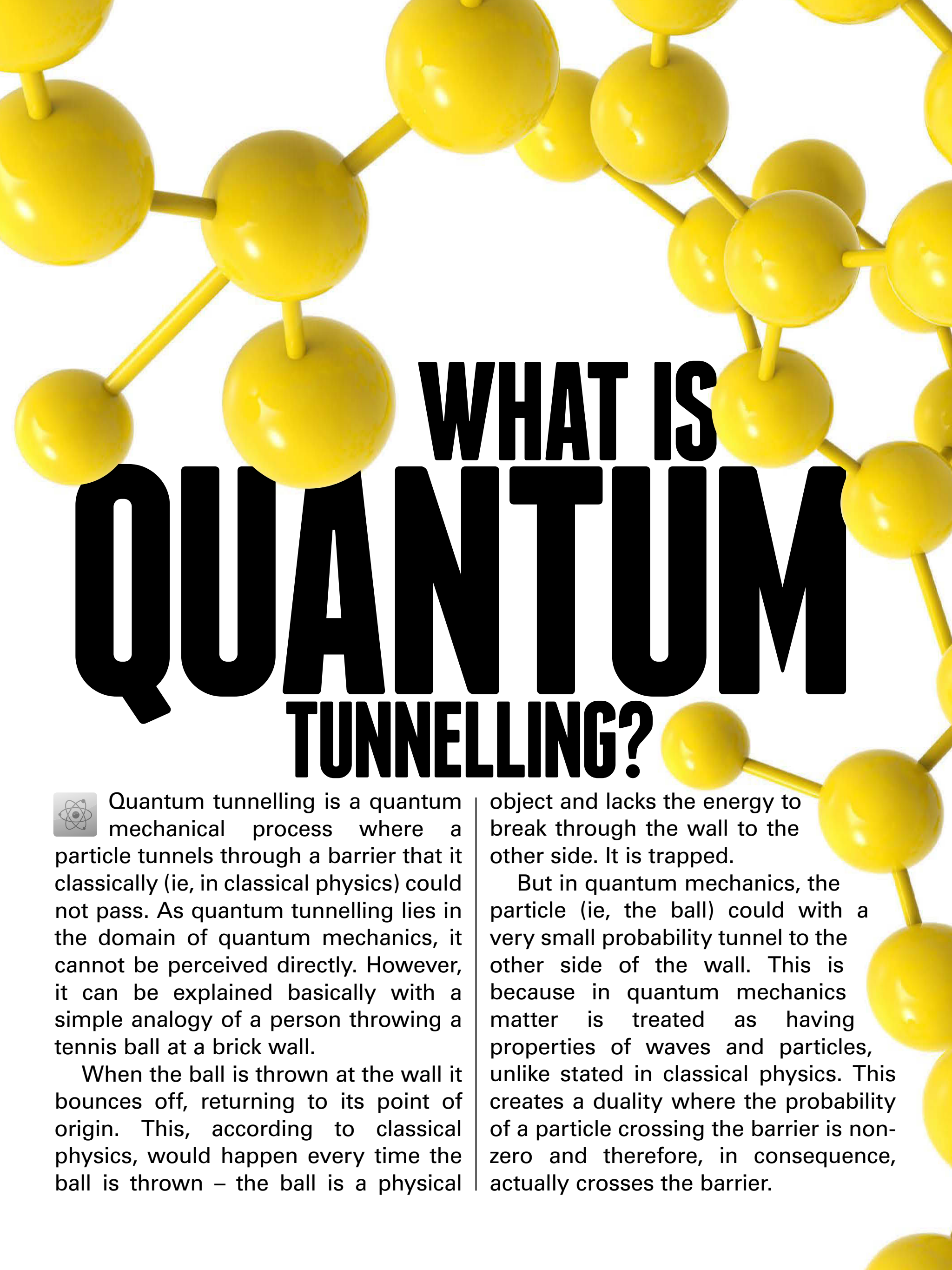
This is Mclaren's concept for an F1 car controlled by thought power. Electrical patterns in the driver's brain would operate the main controls. Sensors would constantly monitor levels of fatigue and focus.

THAT'S AMAZING

When the Sun ejects matter containing up to one billion tons of electrons and protons, the result is scenes such as this above Grotfjord, Norway, as they react with molecules in our upper atmosphere.

WHAT'S THE RAREST BIG CAT?

The rarest big cat in the world is the Amur leopard (*panthera pardus ssp. orientalis*). There are less than 30 left in the wild and the population is declining, which means they are critically endangered. They face various threats including habitat loss, poaching and climate change. The Amur leopard is a subspecies of leopard (*panthera pardus*) that includes the more familiar African leopard, which as a whole species is not as rare. At the species level, snow leopards (panthera uncia) are rarer, with an estimated 4,080-6,590 remaining. You can find out more about endangered species at the IUCN Red List website, which can you can visit at www.iucnredlist.org.



WHAT IS QUANTUM TUNNELLING?

Quantum tunnelling is a quantum mechanical process where a particle tunnels through a barrier that it classically (ie, in classical physics) could not pass. As quantum tunnelling lies in the domain of quantum mechanics, it cannot be perceived directly. However, it can be explained basically with a simple analogy of a person throwing a tennis ball at a brick wall.

When the ball is thrown at the wall it bounces off, returning to its point of origin. This, according to classical physics, would happen every time the ball is thrown – the ball is a physical object and lacks the energy to break through the wall to the other side. It is trapped.

But in quantum mechanics, the particle (ie, the ball) could with a very small probability tunnel to the other side of the wall. This is because in quantum mechanics matter is treated as having properties of waves and particles, unlike stated in classical physics. This creates a duality where the probability of a particle crossing the barrier is non-zero and therefore, in consequence, actually crosses the barrier.

WHY DO ONIONS MAKE OUR EYES WATER?

This is down to a unique chemical reaction. It starts underground, as a growing onion will absorb sulphur from the earth, causing molecules known as sulphoxides to form. When you cut into an onion, you're breaking into its cells, which release certain enzymes. These enzymes react with the sulphoxides, converting them into sulphonic acids. This combination results in the release of a vapour that will irritate your eyes. To flush out the irritation, nerve endings in your cornea will inform your brain of the aggravation, which will instruct the lachrymal glands above your eyelids that can regulate the release of tears, to flush it out by making you cry.

5 COOL THINGS WRIGHT BROS

1 Neither of the Wright brothers married throughout their lives. Wilbur is recorded as once saying that he "did not have time for both a wife and an airplane."

2 Wilbur and Orville were the only members of the Wright family who didn't attend college. Orville spent the years learning the printing trade, while Wilbur helped at the local church.

3 In 1909 the Wright Company was incorporated with Wilbur as president and Orville as one of two vice-presidents. The company's factory was based in Dayton and their flying field was at the nearby Huffman Prairie.

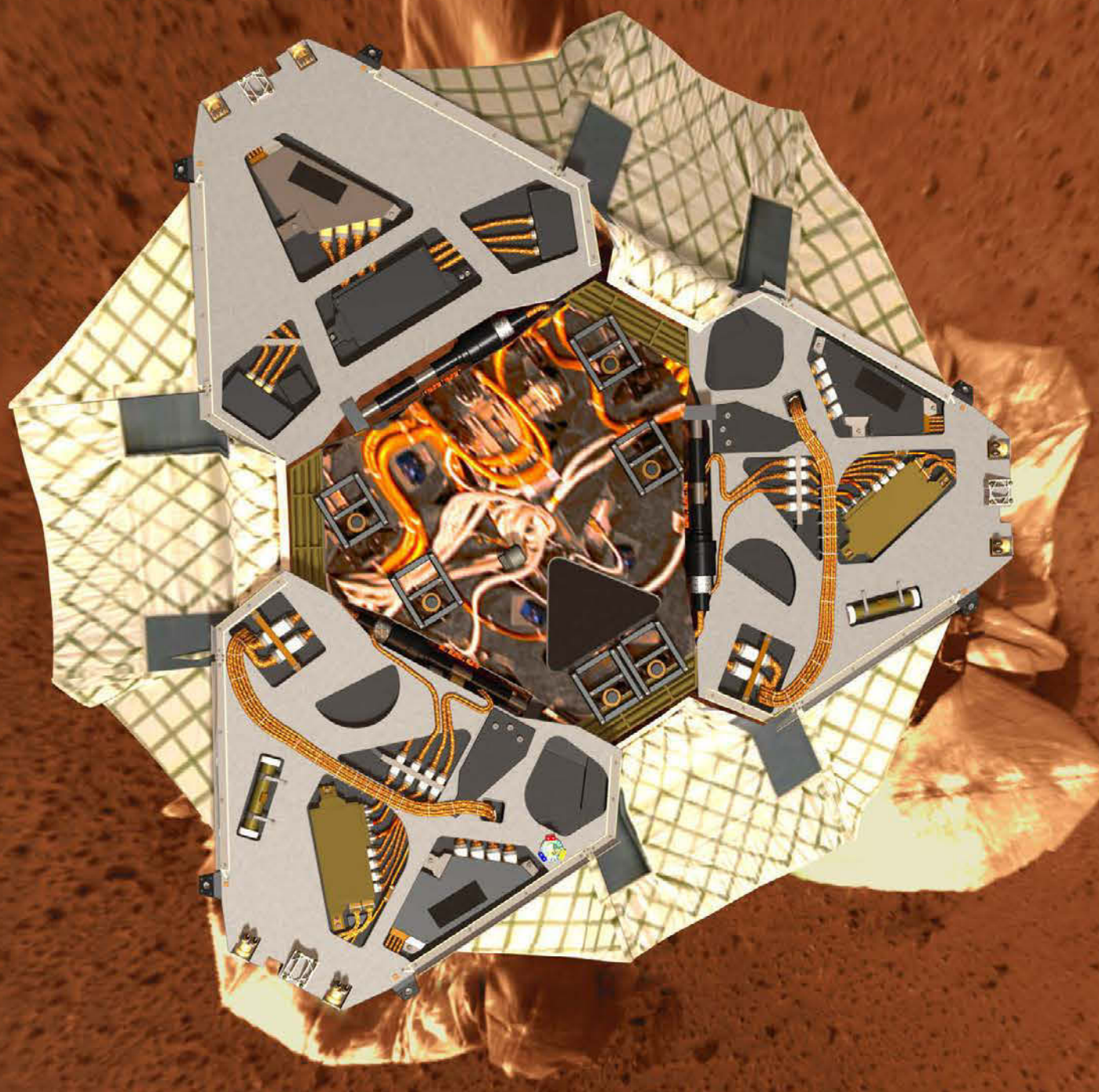
4 In their later lives, the Wright brothers attributed their fascination with flying machines to a small toy helicopter, which their father had brought home one day from his travels.

5 Both extensively catalogued their aviation experiments, leading to Wilbur Wright delivering a talk at the prestigious Western Society of Engineers in Chicago in 1901. The speech was entitled 'Some Aeronautical Experiments'.

WHY DON'T TOUCHSCREENS WORK WITH GLOVES?

Most touchscreens use capacitive sensing. This uses two glass layers, coated on their inside surfaces with stripes of a transparent conducting material. On one layer the stripes run horizontally; on the other they run vertically. Each intersection acts as a tiny capacitor that stores an electric charge. When you touch the glass, your finger distorts the electric field and changes the amount of charge the capacitors underneath it can hold. But this only works because your finger conducts electricity. With gloves on, your fingers are insulated and don't distort the electric field.

WHY ARE WE STILL SENDING PROBES TO MARS?

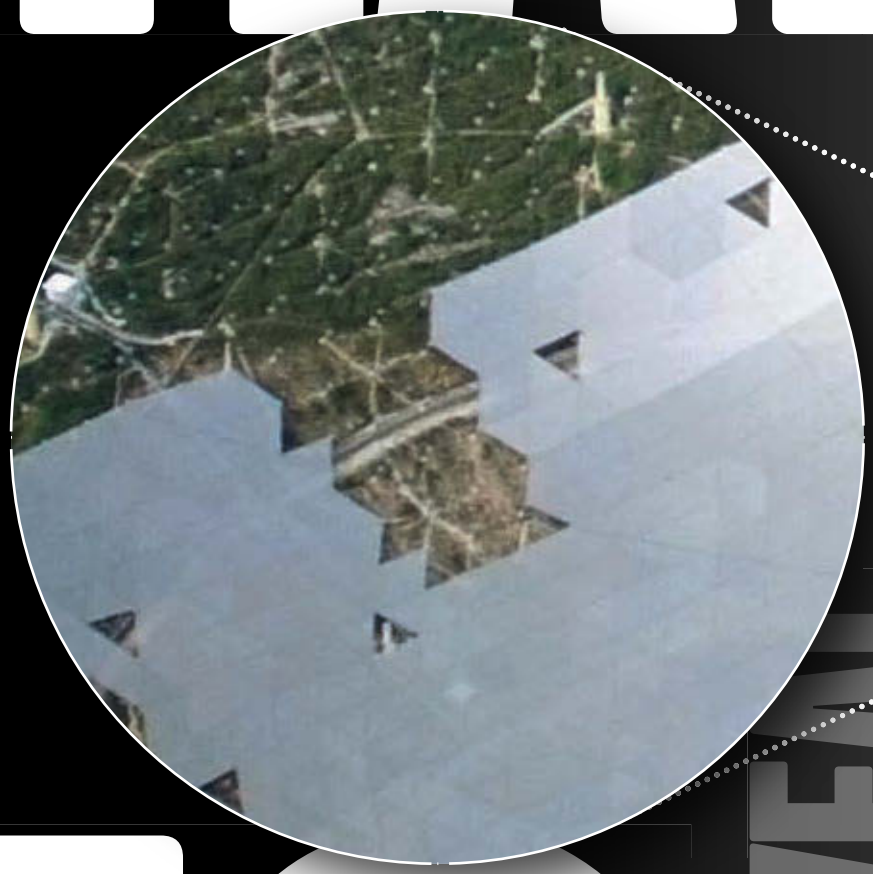


There's a huge amount still to find out about Mars. Despite its more-or-less uniform colour, Mars is a hugely diverse world, with a variety of different environments and landscape features – we really have only scratched the surface, but as we do so, we are discovering evidence for an increasingly Earth-like past, raising major questions that we still can't fully answer. How much water flowed on the surface? Did Mars ever have seas? What happened to its atmosphere and oceans? Did simple life ever manage to get a foothold and might it still cling on somewhere? These are mysteries that recent craft like MAVEN and MOM are hoping to solve.

CAN ENERGY BE DESTROYED?

The law of conservation of energy states that energy cannot be created nor destroyed, only transferred from one form to another. Energy can exist in different forms, such as thermal (heat), kinetic (movement) and potential (stored). Not all energy is transferred to 'useful' forms of energy though – when you run, some of the chemical potential energy you use (from food) is 'lost' as heat and sound. According to some scientists, all energy and mass were created when the universe was born in the Big Bang nearly 14 billion years ago, and energy can be converted into mass (and vice versa).

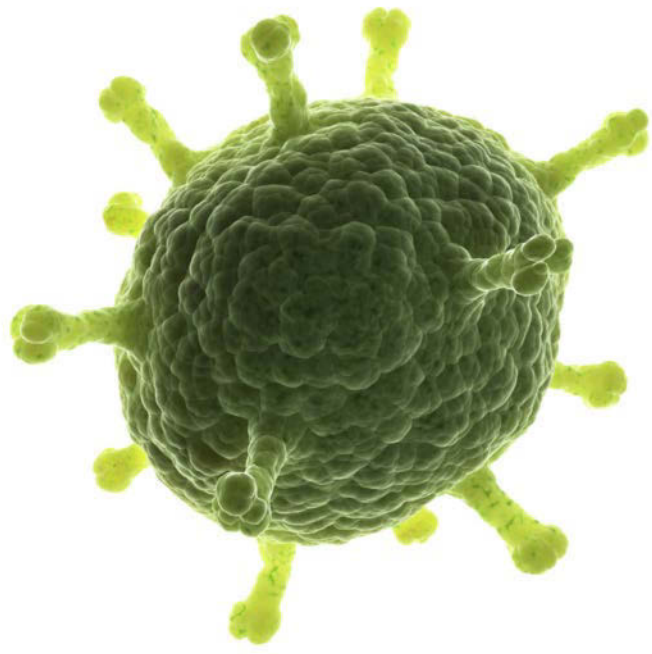
WHAT IS IT?



SWIPE TO REVEAL

THE FAST TELESCOPE

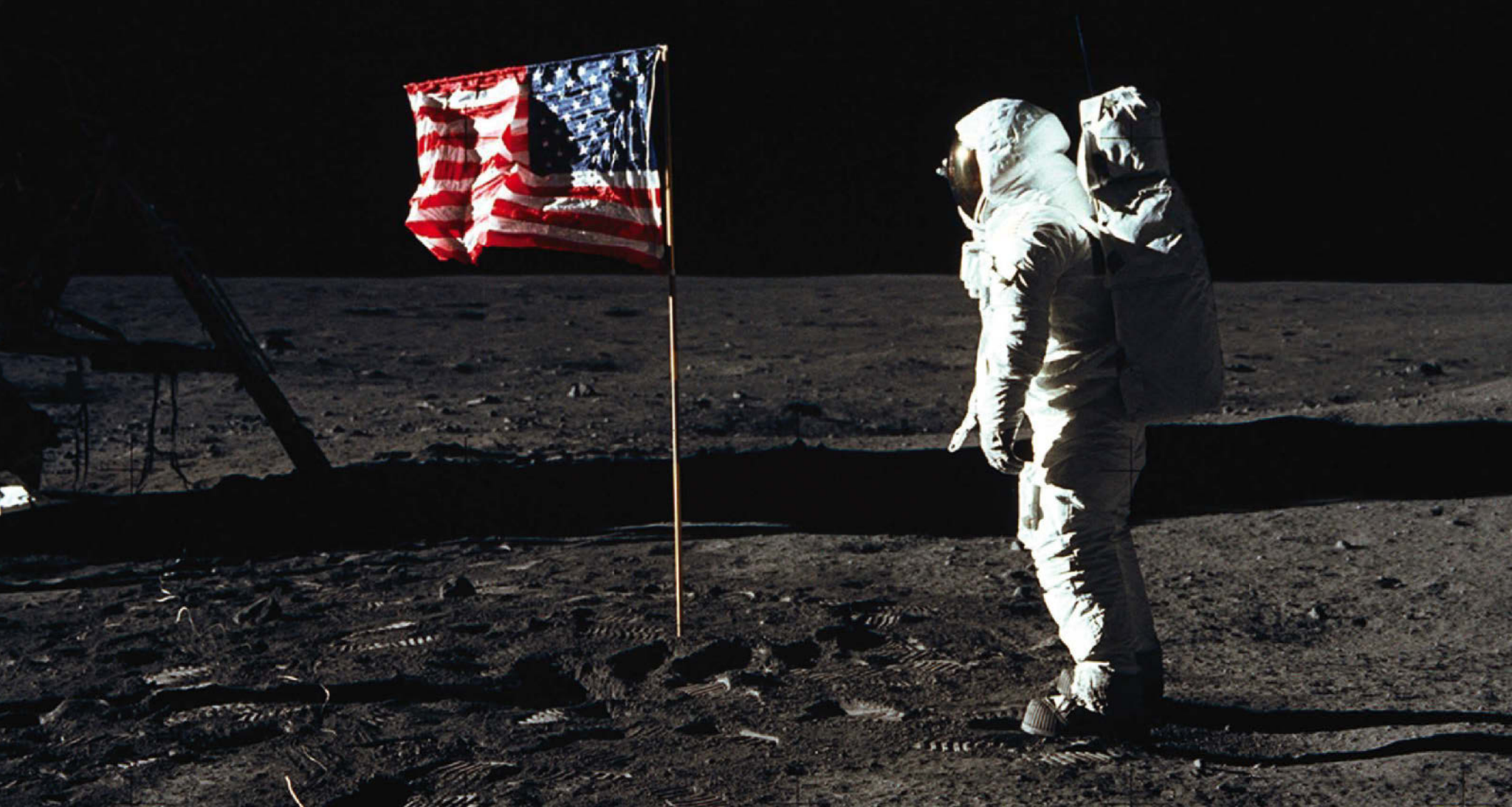
It's the Five-hundred-metre Aperture Spherical radio Telescope (FAST) and it's currently undergoing the last stages of its construction in China's Pingtang County. With a dish the size of 30 football pitches, the telescope will be able to pick up radio signals from billions of light years away, helping us search for distant galaxies and listen out for extraterrestrial life.



HOW DO WE BECOME RESISTANT TO ANTIBIOTICS?

It's not us that become resistant, it's the bacteria we are trying to kill. Bacteria multiply quicker than other organisms and have simpler genomes, so random mutations happen more often. Some of those might give them a tougher cell wall or a way to metabolise a toxin. Low doses of antibiotics given to farm animals, and as medicine to humans who don't really need it, provide an environment that only kills the weaker bacteria. The ones that are left are those with the genes for antibiotic resistance, so they go on to multiply and spread those genes.

WHO OWNS SPACE?



The 1967 Outer Space Treaty explicitly forbids any government from claiming ownership of any celestial object or the empty space in between them. 100 nations have signed and ratified this treaty, including all those currently with a space programme. The treaty doesn't mention ownership claims by individuals or corporations though and this loophole has been exploited by entrepreneur Dennis Hope, among others, to justify selling plots of land on the Moon. The 1979 Moon Treaty attempted to close this loophole, but virtually no countries signed up to it. Videogame developer Richard Garriott bought the Russian Lunokhod 2 rover for $68,500 at auction in 1993. Since this rover is still on the Moon, Garriott might be able to claim ownership of at least part of the lunar surface. In practice, claiming ownership and enforcing that claim are very different things. Consider the geostationary orbit. This area of space is commercially valuable and relatively crowded. Individual satellites are allocated 70-kilometre (43-mile)-wide slots. Some of the equatorial countries tried to claim a slice of the geostationary orbit as part of their airspace back in 1976, but everyone ignored them.

WHAT IS DUST MADE OF?

The composition of dust depends on where the dust is located and the habits of the people who live there. There's a myth that most dust inside your house primarily comprises flakes of shed human skin, but that's not true. Most of your skin flakes go down the drain when you wash. Dust does have some nasty bits in it, though. There's some skin, granted, but there can also be hair, animal dander and fur, soil, dead insects and their faeces, sand, food particles, pollen, bugs, fibres from clothing and linens, pollution and soot.

WHAT ANIMAL HAS THE MOST POWERFUL BITE?

That would be the saltwater crocodile. Bite force is partly about raw size, but it also has a lot to do with the shape of the jaw and the position of the muscles. Bite force hasn't been measured directly for every known animal, but those we have measured allow us to estimate the bite force of the others, simply by measuring their skulls. Humans bite with a force of about 890 Newtons (200 pounds force), while lions and tigers bite five times harder at 4,450 Newtons (1,000 pounds force). At the top end, saltwater crocodiles' bite is almost four times harder again at 16,460 Newtons (3,700 pounds force).

WHY IS SEAWATER SALTY?

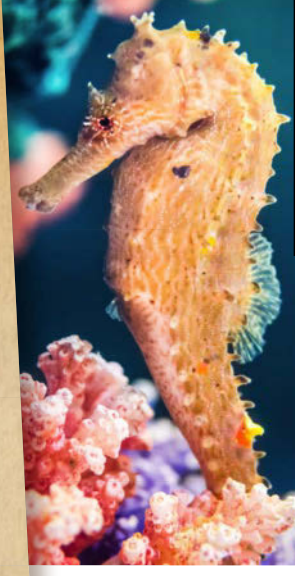
Most of the salt in the ocean comes from a process that takes place on land. Rainfall contains carbon dioxide from the atmosphere, making it acidic. As rain erodes rocks on land, it releases ions – atomic particles that carry an electric charge. Rivers and streams carry these dissolved ions out to the ocean. Some are removed from the water by various plants and animals, while other ions – mainly sodium and chloride – remain and become more concentrated. These two ions are what make seawater salty. It's estimated that if all of the oceans were evaporated and their salts were spread evenly on the entire surface of the Earth, it would form a 152-metre (500-foot)-thick layer.

HOW DO MATCHES WORK?

The friction created when you strike a match triggers a series of chemical reactions, causing it to ignite and then combust. To produce a flame, you need something to burn (fuel), oxygen and enough heat. The match head contains sulphur, glass powder and an oxidising agent. Meanwhile, the striking surface is made of sand, powdered glass and red phosphorus. The heat generated when you strike the match converts some of the red phosphorus into unstable white phosphorus, which spontaneously ignites. This starts a chemical reaction, allowing the oxidising agent to produce oxygen. The presence of heat and oxygen allow the sulphur to combust, creating a flame.

NATURAL WONDERS of the world

Seahorses



SWIPE FOR MORE

Seahorses, along with pipefish and sea dragons, are the only known animals where the males bear the young

LIFE CYCLE OF A SEAHORSE

Learn about a species where the males bear the young

7. Mature adult

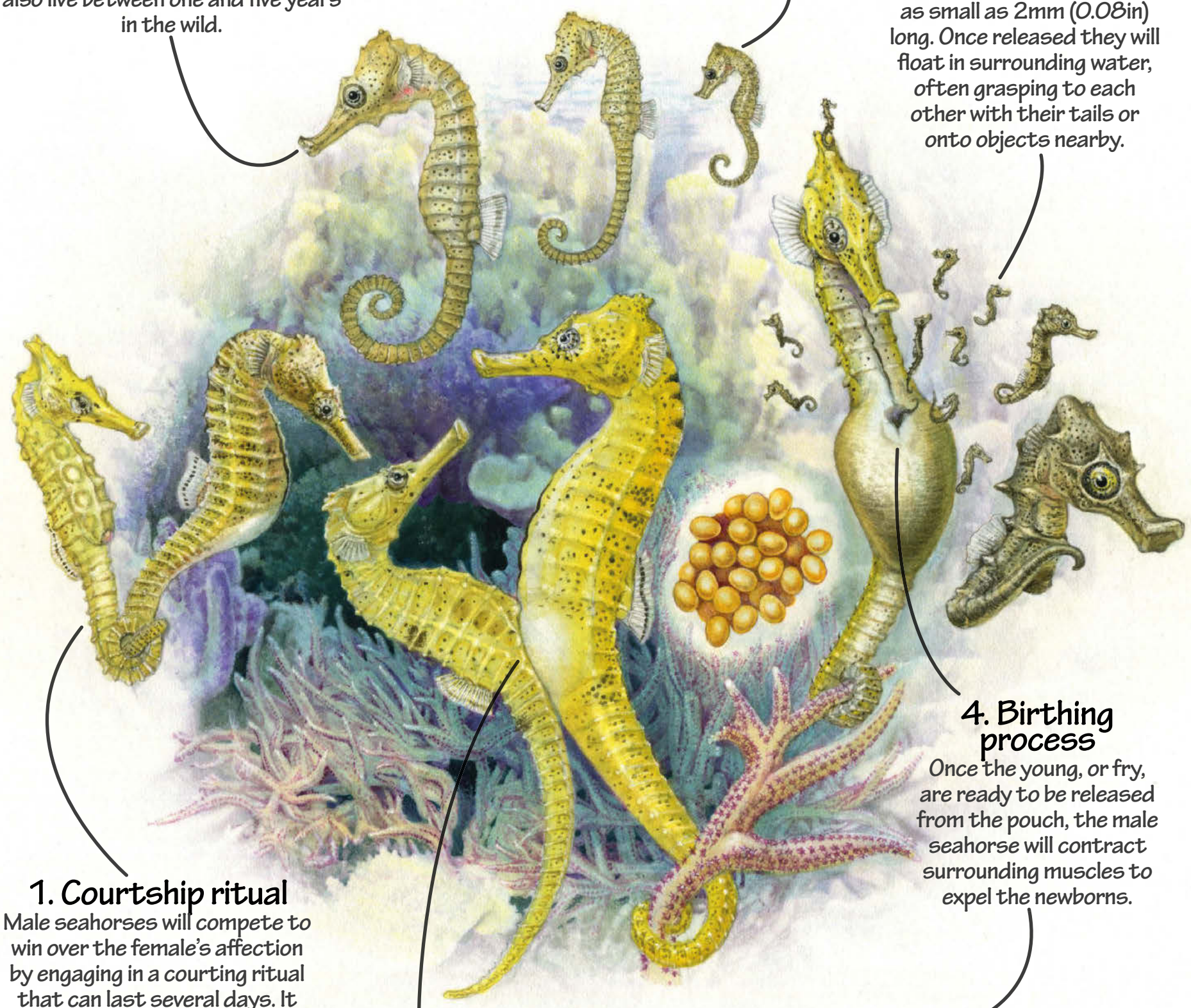
Once fully matured at around six months old, male and female seahorses can continue the life cycle during the breeding season. They can also live between one and five years in the wild.

6. Developing juvenile

After birth the young seahorse will continue to grow in size. They use their dorsal fin to swim and will feed on small crustaceans.

5. Floating fry

Most seahorse species produce around 100 to 200 young, and they can be as small as 2mm (0.08in) long. Once released they will float in surrounding water, often grasping to each other with their tails or onto objects nearby.



1. Courtship ritual

Male seahorses will compete to win over the female's affection by engaging in a courting ritual that can last several days. It involves the male and female entwining tails, dancing and even changing colour.

2. Depositing the eggs

Once the female has chosen a mate, she will deposit her eggs into his brood pouch where they will be fertilised by his sperm and then embedded into the spongy pouch wall.

3. Male pregnancy

The male seahorse provides all of the oxygen and nutrients the embryos need in order to develop into fully formed young. Pregnancy can last between two and six weeks, depending on the surrounding water temperature and species of seahorse.

4. Birthing process

Once the young, or fry, are ready to be released from the pouch, the male seahorse will contract surrounding muscles to expel the newborns.

DO PHOTONS HAVE MASS?

Photons are tiny packets of light, and have energy in the form of electromagnetism. They don't have mass, but momentum – a property usually attributed to an object's mass. The momentum of a photon is dependent on its frequency. Think of a photon as a little packet of energy made of oscillating electric and magnetic fields. Like any wave it has a frequency which determines the type of radiation it makes up. If it's a low frequency it might be radio waves; a high frequency could be X-rays.

Another effect that makes light appear to have mass is that it interacts with gravity. Einstein's Theory of General Relativity explains how stars and black holes have so much gravity that space and time around them is warped. So light travels in a straight line, but its path has become curved due to bending of space-time.

WHY ARE SLUGS ATTRACTED TO BEER?

Slugs like yeast. They can smell the yeast in beer from about half a metre (1.6 feet) away, so you need to place beer traps no more than a metre (3.3 feet) apart. Beer traps aren't very effective, though. Studies with time-lapse cameras have shown that most slugs manage to drink from a beer trap without falling in. The few that do topple in aren't affected by the alcohol; fortifying a slug trap with extra alcohol doesn't help and they work just as well using bakers' yeast and sugar. Slugs die in beer traps because they fall in and drown, not because they get drunk.

HOW DO STREETLIGHTS LIGHT UP?

A cadmium sulphide photoresistor (CdS cell) changes the resistance of a circuit depending on the amount of light shining on it. When lots of light falls on a CdS cell, resistance is low, so it conducts electricity well. When there is little light, the photo-resistor has a high resistance, so not much current can flow. The change in current can be used to control a relay. A relay is an electromagnetic switch; when the electromagnet has a high current (lots of light falling on the photo-resistor) it pushes the switch open so no current can flow to the streetlight. When it gets dark, not much current can flow to the electromagnet so the switch closes and allows electricity to flow to the streetlight, turning it on.

WHAT'S THE LARGEST SPECIES OF TREE IN BRITAIN?

The largest British tree by volume is a sessile oak in Herefordshire, which is believed to take up 107.6 cubic metres (3,800 cubic feet). In terms of height, a Douglas fir in Scotland has been identified as Britain's tallest tree, reaching 66.4 metres (217.1 feet). However, there may be larger candidates that have not yet been measured.

AMAZING SCIENCE EXPERIMENTS

THAT YOU CAN DO AT HOME

FANTASTIC PLASTIC

EQUIPMENT

Saucepan
Food colouring
Spatula
Stove
Starch
Water
Glycerine (from a pharmacy)
Vinegar
Tin foil

1. To start, take your saucepan and add four tablespoons of water and a single tablespoon of starch. Add a teaspoon of vinegar and glycerine to the mix and stir vigorously until it is completely mixed together.

2. Take the saucepan and place it on the stove on a low heat. Stir the mixture continuously as it warms up. As the mixture heats it will transform from a murky liquid into a clear gel. When the transition is complete, the gel should be transparent.

3. When the gel turns clear and begins to bubble, mix in your food colouring. Take the pan off the stove and spread the gel across a sheet of tin foil into any shape. Make it as thin a spread as possible. Leave the tin foil in a safe place for 24 hours. If the experiment has been conducted properly, after this time the gel will have hardened into a sheet of homemade plastic.

WHAT HAVE YOU LEARNED?

This helps demonstrate the ease of construction and versatility of plastic, highlighting the reason for its widespread use. Plastics are made from synthetic or organic solids and typically are polymers of a high molecular mass. They are very malleable, a quality for which they are prized, as they can be easily moulded, cast, pressed or extruded into a variety of shapes. This makes plastic ideal for applications where a lightweight flexible material is desired, like fizzy drink bottles. This experiment shows both the malleable nature of plastic and also how plastics are created by heating raw ingredients and dying them for a certain colour. Plastics are broken down into two categories – thermoplastics and thermosetting polymers. The former are plastics that do change chemically when heated and can be re-moulded continuously, while the latter are those that don't change and can only be melted and moulded once.

ANATOMY OF

HMS ASTUTE

LOOK BENEATH THE HULL OF THE WORLD'S MOST ADVANCED SUBMARINE

PROPULSOR
Ultra quiet multi-bladed propeller which makes less noise than a baby dolphin. Hull is lined with rubber tiles to absorb internal noise

FUEL
Nuclear reactor powers the sub for full service life of 25 years

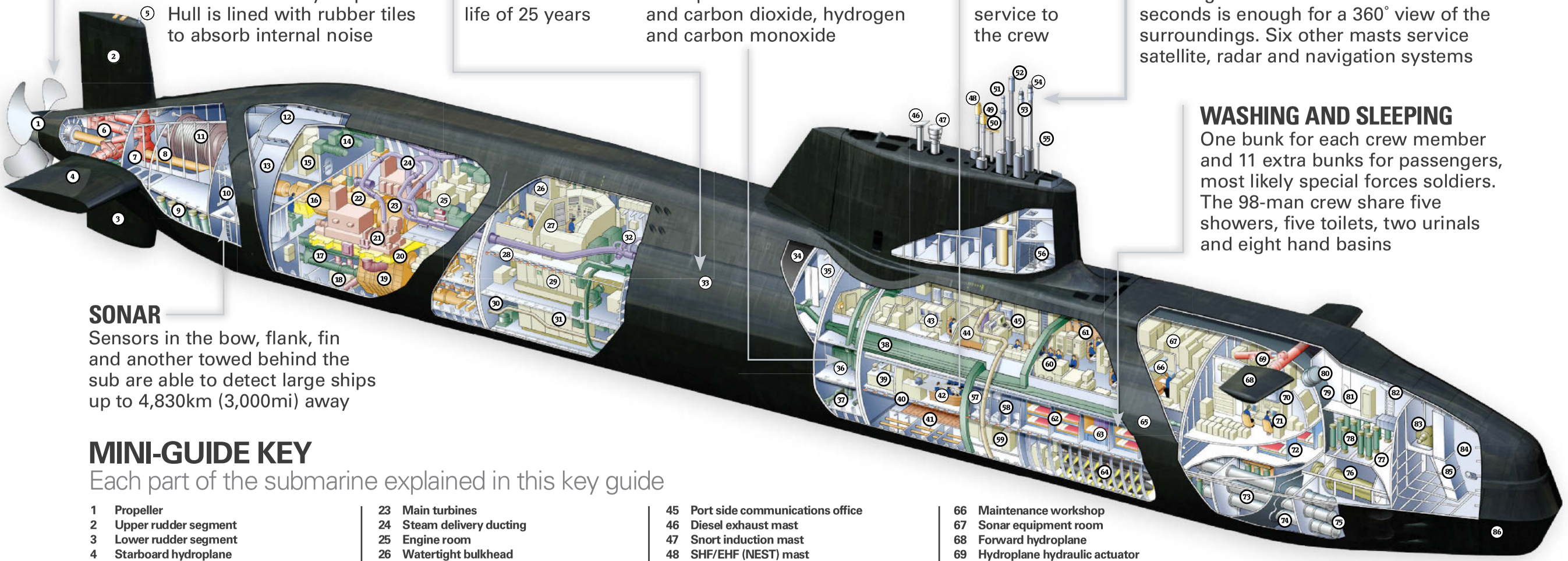
AIR AND WATER
These units convert sea water into fresh water and oxygen. Air is purified to remove waste and carbon dioxide, hydrogen and carbon monoxide

GALLEY
Five chefs provide a 24-hour service to the crew

MASTS
Two masts carrying thermal imaging and low-light cameras replace the periscope. Breaking the surface for less than three seconds is enough for a 360˚ view of the surroundings. Six other masts service satellite, radar and navigation systems

WASHING AND SLEEPING
One bunk for each crew member and 11 extra bunks for passengers, most likely special forces soldiers. The 98-man crew share five showers, five toilets, two urinals and eight hand basins

SONAR
Sensors in the bow, flank, fin and another towed behind the sub are able to detect large ships up to 4,830km (3,000mi) away

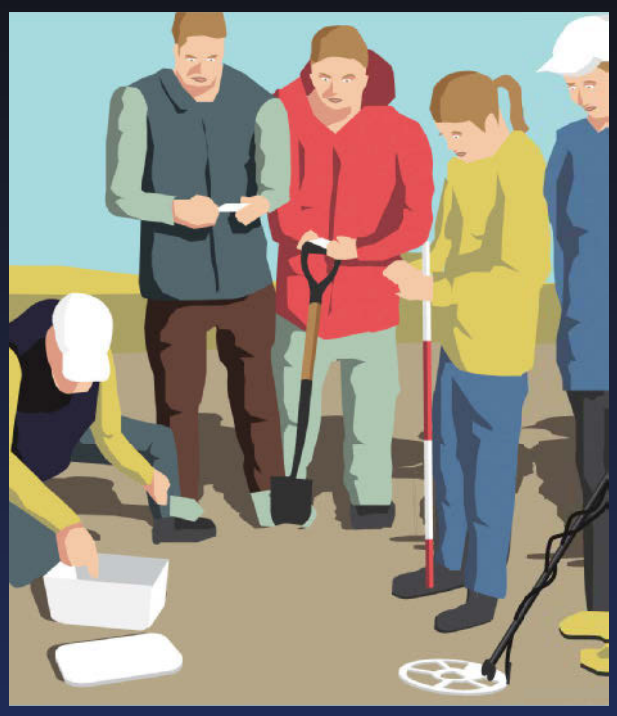


MINI-GUIDE KEY
Each part of the submarine explained in this key guide

1 Propeller
2 Upper rudder segment
3 Lower rudder segment
4 Starboard hydroplane
5 Aft anchor light
6 Rudder and hydroplane hydraulic actuators
7 No. 4 main ballast tank
8 Propeller shaft
9 High pressure bottles
10 No. 3 main ballast tank
11 Towed array cable drum and winch
12 Main ballast vent system
13 Aft pressure dome
14 Air treatment units
15 Naval stores
16 Propeller shaft thrust block and bearing
17 Circulating water transfer pipes
18 Lubricating oil tank
19 Starboard condenser
20 Main machinery mounting raft
21 Turbo generators, port and starboard
22 Combining gearbox
23 Main turbines
24 Steam delivery ducting
25 Engine room
26 Watertight bulkhead
27 Manoeuvring room
28 Manoeuvring room isolated deck mounting
29 Switchboard room
30 Diesel generator room
31 Static converters
32 Main steam valve
33 Reactor section
34 Part of pressure hull
35 Forward airlock
36 Air handling compartment
37 Waste management equipment
38 Conditioned air ducting
39 Galley
40 Fwd section isolated deck mountings
41 Batteries
42 Junior ratings' mess
43 RESM office
44 Commanding officer's cabin
45 Port side communications office
46 Diesel exhaust mast
47 Snort induction mast
48 SHF/EHF (NEST) mast
49 CESM mast
50 AZL radar mast
51 Satcom mast
52 Integrated comms mast
53 Visual mast – starboard
54 Visual mast – port
55 Navigation mast
56 Bridge fin access
57 Junior ratings' bathroom
58 Senior ratings' bathroom
59 Battery switchroom
60 Control room consoles
61 Sonar operators' consoles
62 Senior ratings' bunks
63 Medical berth
64 Weapons stowage and handling compartment
65 Sonar array
66 Maintenance workshop
67 Sonar equipment room
68 Forward hydroplane
69 Hydroplane hydraulic actuator
70 Hydroplane hinge mounting
71 Ship's office
72 Junior ratings' berths
73 Torpedo tubes
74 Water transfer tank
75 Torpedo tube bow caps
76 Air turbine pump
77 No. 2 main ballast tank
78 High pressure air bottles
79 Forward pressure dome
80 Weapons embarkation hatch
81 Gemini craft stowage
82 Hinged fairlead
83 Anchor windlass
84 No. 1 main ballast tank
85 Anchor cable locker
86 Bow sonar

Built at Europe's largest submarine dockyard, Astute first emerged to public gaze in 2007

HOW TO HUNT FOR TREASURE

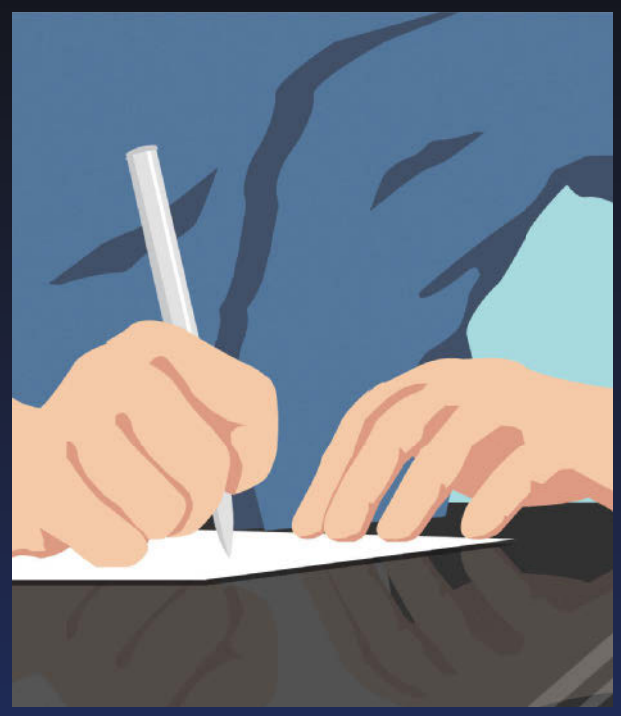


1 BUYING THE DETECTOR

Metal detectors cost anywhere from £35 to £500 ($60 to $830), depending on its ability to differentiate between precious and worthless metals. Some metal detectors are able to operate in shallow water.

2 PICK A GOOD SPOT

Money and jewellery tend to get dropped and buried on the beach, or washed up from the sea. However, you could carry out some research and hunt in known historical sites, such as around hill forts and castles.



3 GET PERMISSION

Searching on private land requires permission from the landowner. Public beaches even need a permit from the Crown Estate to be searched. And some coastlines are protected for historical or environmental value.

4 CHECK DISCRIMINATION

This is the range of metals your machine is set to pick up. Higher levels will only find precious metals; lower levels will alert you to lower-value metals like aluminium. Note: Roman and Celtic coins fall under lower-discrimination levels but are still valuable.

5 SWEEP MOTION

There's a special technique, which involves walking slowly in a straight line and sweeping widely. Reach a predetermined point, move a metre or so to the side and start again. Overlap your previous sweep in case you disturbed or missed something. If you strike lucky, sweep that area again, as sometimes if one thing has been dropped in that area, more will be in the vicinity.

TOTAL WEIGHT

10,100 TONS

2.5MN RIVETS

HEIGHT 324M

BASE AREA 2.54 ACRES

STATISTICOOL

EIFFEL TOWER

AGE 127 YRS

STEPS TO THE TOP 1,665

COST $1.5MN